Sectors 16, 17, and 28. The second figure shows the tool at Sectors 16 and 17. Conflict-resolution trajectories were developed by test controllers using the tool, and the trajectories were then suggested to the sector controllers for clearance to the aircraft. During 88 sector-hours of testing, 175 tool-aided resolutions were suggested to sector controllers and about 72% of these resulted in clearances to aircraft. Compared with the Phase I results, there was a 26% increase in the number of direct route resolution clearances actually issued to aircraft. The tool's ability to confirm that a trial plan resolves a conflict and does not create other conflicts was consistently rated as "highly beneficial" by the controllers.

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Fig. 2. Conflict prediction and resolution tool setup at Sectors 16 and 17, Denver Center, September 1997.

Conflict Probe Performance Evaluation

Karl D. Bilimoria

A conflict probe is a software tool that assists air traffic controllers in maintaining safe separation between aircraft by predicting conflicts up to 20 minutes in advance, using information on aircraft state (track data), intent (flight plans), and atmospheric conditions (wind and temperature). Such a tool would be especially useful in a "free-flight" environment, which is expected to have a less structured traffic flow than is afforded by the current operating environment. The objective of this research is to develop a comprehensive method for quantitatively evaluating the performance of any conflict probe, and then to apply the method to the Center/TRACON (Terminal Radar Approach Control) Automation System (CTAS) Conflict Probe Tool developed at Ames Research Center.

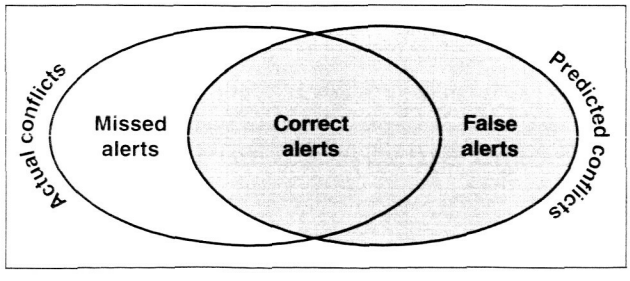

Fig. 1. Schematic of conflict probe primary metrics.

Several metrics of conflict probe performance have been developed and evaluated. The missed-alert rate and false-alert rate are primary metrics that quantify the reliability of a conflict probe. As shown in the first figure, missed alerts are actual conflicts that were not predicted, false alerts are conflicts that were predicted but did not actually occur, and correct alerts are conflicts that were predicted and actually occurred. The mean conflict warning time and root-mean-square errors in key conflict prediction parameters such as minimum horizontal and vertical separations are important secondary metrics that quantify the accuracy of a conflict probe. The CTAS Conflict Probe Tool was exercised with almost 4000 tracks of actual traffic data from the Denver Air Route Traffic Control Center, using expanded conflict windows (see the second figure). Techniques have been developed to identify those conflicts associated with imprecise intent information (e.g., controller clearances not entered as flight plan

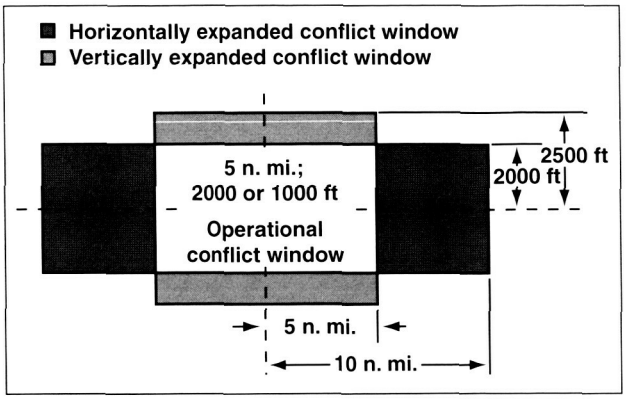

Fig. 2. Examples of expanded conflict windows.

amendments), and to appropriately adjust missed- and false-alert rates for those cases.

Preliminary results indicate that overall conflict probe performance is dependent on conflict geometry distributions and on the parameters of the expanded conflict windows. It is expected that the final results will provide guidelines for the performance that can be expected from a conflict probe based on current technology for aircraft tracking and weather prediction.

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Collaborative Arrival Planning

Rick Zelenka

The continued expansion of air-traffic and air-carrier economic pressures is necessitating changes in the relationship between the air traffic control service provider and the system user. Such pressures have resulted in efforts to increase the flexibility of air traffic management operations and allow collaboration between the service provider and system user. The government/industry "free-flight" initiative, whose ultimate vision is to allow users to select their own flightpath and speed in real time with air traffic control (ATC) imposing restrictions only when necessary, is the most visible of such efforts. Shared decision making and collaboration between system users and service providers have been identified as providing benefits necessary to support subsequent phases of free flight.

In the terminal arrival phase of flight, many restrictions and a high degree of control are placed on system users without regard for individual user operational preferences. Air traffic procedures do not allow the system users to prioritize their arrival sequence. For example, in hub operations, airlines may have preferences based on ensuring connections to overseas flights or gate availability that significantly affect their economics of operation.

The Collaborative Arrival Planning (CAP) service-provider/system-user decision-support tools should increase air traffic management flexibility and increase the economic efficiencies for system users. CAP is an extension of the Center/TRACON (Terminal Radar Approach Control) Automation System (CTAS), a suite of decision-support tools that provide computer-generated advisories for both en route and terminal-area controllers to manage and control arrival traffic more efficiently. CTAS has been selected by the Federal Aviation Administration (FAA) for national deployment. CTAS CAP will allow the user to request and influence intra-airline arrival characteristics without negatively affecting ATC operations. A tactical CAP tool will assist and improve the handling of individual aircraft arrival preferences. The strategic CAP tool will alter the CTAS arrival sequence within an individual airline's planned arrivals based on relative priority without affecting the priorities of other carriers.

Specific CAP accomplishments during FY97 include the following:

1. The design and development of a specialized airline CTAS "repeater" system. This system shares the CTAS arrival scheduling and airspace management information with the airspace user. Such real-time sharing of scheduling information is a significant first step in airspace user and service-provider collaboration and more efficient airline operations.

2. The design and development of a simulated airline "hub management" workstation to support the